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A Domain Ontology for Platform Ecosystems

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Abstract. Platforms have disrupted several business sectors and daily life in general. Platforms facilitate collaboration between different partners, which leads to the emergence of an ecosystem. During recent years, both research fields platforms and ecosystems have made significant progress. Since the terminologies originate from different backgrounds and are put into play in various sectors, a certain vagueness surrounds platforms and ecosystems. The present paper, therefore, adds to academia by providing an ontology – an abstraction of a real-world phenomenon – for platform ecosystems. The ontology comprises concepts from the platforms, business ecosystems, and platform ecosystems domains. The evaluation with three real-world platform ecosystems from different industries verifies that the platform-ecosystem-specific requirements were met in the ontology.

Keywords: Platform Ecosystem, Domain Ontology, Platform, Ecosystem

1 Introduction

Platforms shape nowadays' business environments. The platform Airbnb supplies its users with more accommodations than the five largest hotel brands together. Uber overshadows local taxi companies by having a network of over seven million drivers [1]. Thus, interest in platforms has sharply increased since the 1990s [2]. Platforms like Airbnb and Uber have established a sharing economy, where competition is about attracting platform activity instead of controlling the value chain [3]. As a result, the platform concept gains momentum for both managers and researchers [4].

Status-quo literature defines platforms from two perspectives, the market-oriented and technological perspective. The market-oriented perspective describes platforms as markets that enable transactions between different groups of actors. In contrast, the technological perspective defines platforms as one fixed core with a variable periphery [5]. Often companies and their partners use a platform to build an ecosystem around it [4]. Research has named these ecosystems *platform ecosystems*. These platform ecosystems comprise a platform as the core and actors in the periphery. Subsequently, platform ecosystems enable value creation by coordinating activities among the different actors [1].

Platform ecosystems have become a rather complex phenomenon since they unify multiple perspectives on platforms and ecosystems. The conceptual ambiguity of platform ecosystems aggravates communication about them [3]. Hence, creating a

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formal ontology – an abstraction of a real-world phenomenon – might help achieve a structured view of platform ecosystems [2].

This contribution aims to develop a domain ontology for platform ecosystems, to provide a consolidated and formal view on the existing knowledge base. Based on a method adapted from Brusa et al. [6], this paper creates the domain ontology. Ontology users who set up or operate a platform ecosystem can gain an overview of the influences in platform ecosystems. Furthermore, an ontology acts as a communication medium between people with different backgrounds and information systems. An ontology should assist the acquisition, representation, structuring, and organizing libraries of knowledge [7].

After presenting the domain ontology, three online case studies demonstrate how the ontology expresses the real-world platform ecosystems Amazon, an airport, and Airbnb.

This paper is structured as follows. Section 2 outlines the theoretical background of this study and related work. After describing the underlying method in Section 3, Section 4 presents the resulting domain ontology in an entity-relationship model with Chen notation. In Section 5, the ontology is evaluated by mapping the entities from the ontology to three real-world platform ecosystems. Section 6 discusses the results, outlines the contribution, and clarifies limitations to this study. In the end, the paper is shortly summarized, and future research is proposed in Section 7.

2 Theoretical Background

2.1 Platforms

Two perspectives dominate the platform literature: the market-oriented perspective and the technological perspective. The market-oriented perspective defines platforms as markets that enable exchange between two or more groups of actors. Therefore, platforms are often referred to as multisided-markets [5]. The central idea of the market-oriented perspective are network effects, which arise between different groups of actors. Research distinguishes two kinds of network effects: direct and indirect network effects. According to De Reuver et al. [3], if the success of the platform depends on the number of users in the same group of actors, network effects are direct. An example of platforms with direct network effects are social media networks. The more people use the platform, the more popular it is, and more new users are attracted to join it [3]. For indirect network effects, however, the success of a platform depends on the number of users in the different groups. An example of platforms with indirect network effects are video game consoles: the more developers are developing compatible games for the console are on the platform, the more people are interested in buying this video game console [3]. Sometimes indirect network effects can also negatively affect the value of a platform. For example, the more advertising partners a search engine has, the lower its value gets for those users who search for independent information [3]. The success of a platform is determined by network effects, which is why platforms must solve the "chicken-and-egg" problem in the initial phase. This problem arises as the platform

does not have any users initially and must attract them by itself. For example, Microsoft initially paid developers to develop apps for the Windows Phone platform to get more users onto the platform [2].

From a technological perspective, platforms have a modular structure. They consist of a fixed core and a variable periphery. The core can contain several components that do not change over time. The core generates economies of scale and economies of scope. An increased production volume decreases fixed costs and lowers the cost of developing new products as the core is fixed [5]. The periphery, on the other hand, is variable and can be adjusted, replaced, or even left out as desired. Platforms connect the core and the periphery via interfaces. These allow the platforms to facilitate innovation and co-creation [8]. Depending on how much information interfaces provide to external groups, the more platform users can participate in the innovation process. However, the technological view of platforms is limited since it cannot explain how the entire platform, including its core, is evolving [2].

Despite the similar architecture of platforms, these have different manifestations. Evans and Gawer [9] classify platforms as four types: transaction platforms, innovation platforms, integrated platforms, and investment platforms. Transaction platforms enable exchanging a service, product, or technology between different users, e.g., PayPal, Netflix, and Spotify [9]. When a platform allows other companies to develop complementary technologies, products, or services, it is an innovation platform. Typical innovation platforms are Intel and Microsoft [9]. If a technology, product, or service is a transactional and an innovation platform, it is called an integrated platform; for instance, Google, Facebook, and Apple. Last, investment platforms consist of companies that have developed a platform portfolio strategy, whereby they act as a holding company. For this definition, Softbank 2015 is a corresponding platform [10].

2.2 Platform Ecosystems

The term ecosystem originates from biology and refers to a union of organisms that relate to each other [10]. Business ecosystems are the fixed arrangement of actors around a focal firm, intending to fulfill a focal value proposition [11]. Thus, an ecosystem has a solid structure, which determines the position of an actor.

Actors are independent economic entities that contribute to the fulfillment of the ecosystem's value proposition. Actors do not need a direct connection to the focal firm to be part of the ecosystem, as its value proposition determines its boundaries. Therefore, an actor contributing to the focal value proposition belongs to an ecosystem. On Airbnb, for example, a host uses pictures from a professional photographer to promote her accommodation. Here, the photographer contributes to the value of the ecosystem without any connection to Airbnb.

To fulfil the focal value proposition, actors depend on each other's activities within the ecosystem. Activities are actions carried out by actors to fulfill the focal value proposition [12]. The ecosystem's strategy is based on how a focal firm determines the arrangement of the actors and ensures its role in the competitive ecosystem. The actors pursue different strategies that affect the structure, roles, and risks of the ecosystem. Finally, the focal firm has the task of arranging its partners as envisioned in its strategy.

A company in the ecosystem either plays the role of a follower or a leader [11]. While focal firms are the leaders who enforce strategy and governance, followers must accept the provisions of the focal firm. Therefore, internal competition between companies regarding position, role, and activities emerges. In addition to internal competition, an ecosystem also competes with other ecosystems [11].

If an ecosystem revolves around a platform, the result is a platform ecosystem with the platform as the core. An essential aspect for platform ecosystems is that the platform opens up and allows complementors to offer products and services via the platform [2]. Complementors are external companies or groups with no direct relationship to the platform owner, but they contribute to the platform [10]. Boundary resources are tools, regulations, or other resources, which enable co-creation within platform ecosystems [13]. The platform takes care of different activities within the ecosystem: The platform determines roles. The aim for the platform is to control ownership, the number of groups it brings together, power-sharing, and relationships with stakeholders.

Furthermore, the platform regulates pricing and revenue distribution within the ecosystem. It determines the competitive strategy of the platform ecosystem, which can be either collaborative, competitive, or a mixture of both [2].

2.3 Related Work

This paper aims to consolidate the literature on platform ecosystems to resolve conceptual ambiguities. Therefore, other structured views on platform ecosystems are considered as related work for the present paper.

Derave et al. [14] present a domain ontology for digital platforms. In doing so, they analyze the most important features of a digital marketplace and present them in an ontology. They divide the overall ontology into three sub-ontologies. The first sub-ontology shows the service offering. In the second ontology, they depict the negotiation within a marketplace. The last ontology displays marketplace service delivery [14]. These ontologies have a specific view of digital marketplaces as they represent different services. While these sub ontologies show some characteristics of platforms and ecosystems, they mainly concentrate on digital platforms. Thus, the market-oriented and the technological perspectives are missing in this representation. The present paper aims to add to existing ontologies with a high-level conceptual overview representing the essential characteristics of platform ecosystems.

Schreieck et al. [2] give an overview of current research on platform ecosystem. Hence, the authors conduct a literature review to denominate the most relevant concepts of platform ecosystems. The paper contributes to the understanding of platform ecosystems in information systems literature [2]. In addition to their work, the domain ontology provides a formal view on platform ecosystems. According to [15] a definition is formal if it provides a an unambiguous specification that is generally understandable and machine processable. Therefore, an ontology acts as a communication medium and also assists to structuring and organizing libraries of knowledge [7].

3 Method

Ontologies specify the common syntax and definitions of terminology systems [16]. It also defines the relations between terms and is shared by many people in a formal way [17]. An ontology that describes phenomena in a particular domain or discipline is a domain ontology [16]. The paper develops a domain ontology for platform ecosystems partly based on the four step method from Brusa et al. [6].
First, the goal and scope of the ontology need to be identified. The scope defines the concepts of the domain that must be included and the ones that must not [6]. The ontology for platform ecosystems focuses on the structure and the flows of money, goods, and services within a platform ecosystem. As a result, the connections between different platform ecosystems and other third parties were excluded from the ontology.

Second, the target domain is analyzed. This analysis identifies the essential components, relationships, and characteristics of platform ecosystems. Hence, specific requirements for the ontology could be identified. While finding the specific requirements the own expectations towards the ontology should also be taken into account [18]. A literature search was carried out to determine specific requirements for platform ecosystems. Section 2 presents the insights from the review. This procedure sets out the following specific requirements for an ontology for platform ecosystems:

- The platform from the market-oriented and technological point of view
- The integration of actors and activities in a platform ecosystem
- The collaboration between ecosystem and platform
- Value creation within the platform ecosystem

Third, based on the specific requirements, the ontology was designed. Therefore, the requirements were categorized so that different components, types, or relationships can be identified [18]. The requirements above can be divided into the category's *platform*, *ecosystem*, and *value creation*. These categories were designed one after the other and merged at the end to achieve the overall ontology. The ontology was developed as an entity-relationship-model using Chen's notation.

Finally, ontologies should be evaluated, adjusted, and improved based on the results. The evaluation verifies whether all requirements have been implemented. Here, various use cases of the target domain can be used to check the quality of the domain ontology [18]. Platform ecosystems with different features were used for this purpose.

4 A Domain Ontology for Platform Ecosystems

This section presents the domain ontology for platform ecosystems. Figure 1 depicts the resulting ontology. Color-codes were used in the figure to indicate the field of origin for each entity and relationship. All green elements are representing the characteristics of an ecosystem. The blue components originate from platforms, and yellow parts are features of platform ecosystems. Parentheses in the metamodel indicate the sources.

Platform ecosystem entities and relationships. At first, the entities and relationships that represent the characteristics of platform ecosystems are introduced.

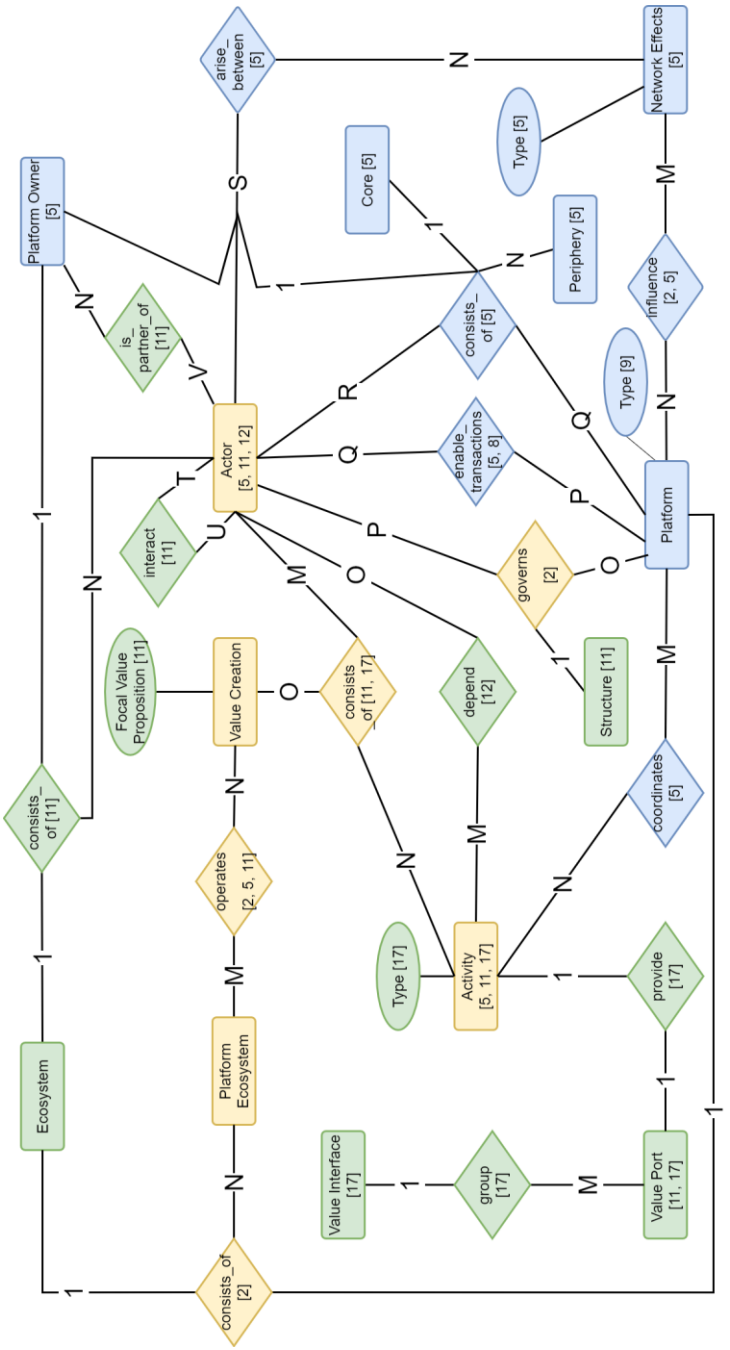

Figure 1. A Domain Ontology for Platform Ecosystems

A platform ecosystem consists of an ecosystem that revolves around a platform [2]. The relationship *consists_of* illustrates this by connecting the entities *Platform Ecosystem, Platform, and Ecosystem.* Because an ecosystem and platform can belong to multiple platform ecosystems, both are 1-to-N relationships. Also, the entity *Platform Ecosystem* was added to the *operates* relationship leading to the *Value Creation* entity to show that value creation occurs in a platform ecosystem.

In an ecosystem, a value creation comprises actors, and activities within the relationship *consists_of.* Actors are members of a platform ecosystem who contribute to its value creation by providing different activities [11]. This relationship is an N-to-M relationship, as distinct actors offer different activities to operate other value creations.

A governance mechanism of platform ecosystems is the determination of pricing and revenue distribution by the platform [2]. In a platform ecosystem, the platform further determines the structure. In the ontology, this is visualized by the relationship *governs* between *Platform*, *Actor*, and *Structure*. A platform ecosystem has only one fixed structure. Therefore, one is selected as the cardinality between the platform and structure.

Ecosystem entities and relationships. Next, the main characteristics of ecosystems were designed. Adner [11, p. 42] defines ecosystems as follows: "The ecosystem is defined by the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize." According to the definition of Adner (2016), an ecosystem has one focal firm.

The focal firm determines the arrangement of the actors and, thereby, the structure of the ecosystem. As a result, the same actors in a different arrangement represent another ecosystem [11]. In a platform ecosystem, the focal firm is always the platform owner. The *Actors* are partners of the *Focal Firm*. In the ontology, this is represented by the relationship *is_partner_of*. Since actors and focal firms can collaborate in more than one ecosystem, the relationship has an N-to-M cardinality. The focal firm and its partners pursue a *Focal Value Proposition* [11]. The ontology, therefore, adds *Focal Value Proposition* as an attribute of the entity *Value Creation*. All components of the ecosystem participate in the relationship *consists_of* between the entities *Ecosystem*, *Actor*, and *Platform Owner*. As a focal firm exists only once in an ecosystem, one is selected as the cardinality between the ecosystem and platform owner.

The recursive relationship *interact* depicts the interaction between *Actors*. As multiple actors can interact with each other, this is an N-to-M relationship.

To realize the focal value proposition, the ecosystem operates value creation, which is shown in the model by the relationship *operates* between the entities *Ecosystem* and *Value* Creation. In [19], the value creation is represented by several so-called value objects that match specific needs or are used to produce other value objects. While a single ecosystem can offer multiple value objects, a value object can also be a part of different ecosystems' value creation. As a consequence, an N-to-M relationship was chosen for the ontology.

Activities need to be carried out to materialize the focal value proposition of an ecosystem [11]. Hence, value objects are activities in the ontology. An activity can be goods, services, or cash-flow. The attribute *Type* of the *Activity* entity in the ontology

indicates whether it is a good, service, or money. Activities are carried out or provided by actors [19]. The same actor can perform multiple activities; meanwhile, multiple actors can perform the same activity [11].

To create value, actors depend on each other's activities [12]. Therefore, the N-to-M relationship *depend* is modeled between *Actor* and *Activity*. To enable the exchange of activities in an ecosystem, actors utilize value ports to deploy or request activities. Value ports are summarized by value interfaces [19]. In the ontology, this can be seen in the relationships *are_provided* and *group*. An *Activity* is provided through a *Value Port*, while several value ports are grouped by one *Value Interface*.

Platform entities and relationships. Finally, the platform aspects were added to the ontology. Therefore, the attribute *Type* was added to the entity *Platform*. According to [20] there are for types of platforms: transaction platforms, innovation platforms, integrated platforms, and investment platforms.

Further, both platform perspectives – market-oriented and technological – are included in the ontology. In the market-oriented view, platforms are influenced by network effects.

Network effects occur between groups of actors. There are two different types of network effects, direct and indirect network effects [5], which is why the *Network Effects* entity has an attribute named *Type*. In the ontology, the influence is represented by the relationship *influence* between the entities *Platform* and *Network Effects*. Within a platform, there can be several network effects, which is why an N-to-M relationship is chosen. As network effects only arise between actors, the relationship *arise_between* concerns *Network Effects* and *Actors*.

From the technological perspective, a platform consists of a core and a periphery. In the ontology, the relationship *consists_of* between the entities *Platform*, *Core*, and *Periphery* illustrates the technological perspective. There is only one core in a platform, which is why all these relationships are 1-to-N relationships. Other components of a platform that belong to the *consists_of* relationships are actors and the platform owner, which use the platform to create value.

The platform also enables transactions between the actors, which is visualized with the *enable_transactions* relationship. A platform creates value by coordinating the activities of actors. It coordinates activities, which in turn are coordinated by a single platform. This is represented by the 1-to-N relationship *coordinates* [5].

Boundary resources belong to the central concepts of platforms. These can be tools, regulations, or other resources used for co-creation [13]. In the ontology, *Boundary Resources* are defined as another type of activity. Platforms are often supported by complementors who offer products that expand the platform's value [5].

5 Evaluation

Platform ecosystems from different industries were analyzed to evaluate the developed ontology and to verify the implementation of the specific requirements. For this purpose, three online case studies were conducted. The selected platform ecosystems are Airbnb, the Albrecht-Dürer Airport from the tourism and travel industry, and

Amazon as an online marketplace. For the evaluation examples from the selected platform ecosystem are mapped for every entity in the ontology. Thereby, the existence of this concepts in the real world is given. The results from the online case studies are summarized in Table 1.

Table 1**.** Mapping between ontology and real-world platform ecosystems

Entities	*Case1: Airbnb*	*Case 2: Albrecht-Dürer Airport*	*Case 3: Amazon*
Platform	Airbnb	Albrech-Dürer Airport	Amazon
Platform Owner	Airbnb, Inc.	Flughafen Nürnberg GmbH	Amazon.com, Inc.
Actor	Host, Travelers	Passengers, Airlines, Shopkeepers, Advertisement partners, Travel agencies	Customers, Companies, Sellers, Logistics
Focal Value Proposition	Convey accommodations and experiences	Provide pleasant traveling experience	Operate online-marketplace
Activity	24-hour-service, templates	Check-in, salesrooms	Goods, templates
Core Periphery	Website backend Web interface	Airport Facilities Service providers	Website backend Web interface
Network Effects	Indirect, Traveler ⇔ Hosts	Indirect, Airlines ⇔ Passenger ⇔ Shopkeeper	Indirect, Customer ⇔ Seller

5.1 Airbnb

Airbnb is a platform where accommodations and experiences can be booked. In return, the platform offers travelers customer service and travel security [21]. Airbnb does not own any accommodations itself. These are only provided by hosts. Hosts have the option to offer their accommodations on Airbnb and pay a service fee to the platform every time a traveler books their accommodation. Besides, Airbnb offers hosts a 24-hour service and pays them the surplus of their accommodation after the traveler has checked-in [22].

First, the components that belong to the main characteristics of platform ecosystems are checked. A platform ecosystem consists of an ecosystem and a platform. The platform, in this case, is Airbnb itself and has the type transaction platform. The ecosystem consists of the platform owner, that is the owner of Airbnb, and the actors. The actors are the travelers and the hosts. They are also partner of the platform owner.

The platform ecosystem operates value creation by offering accommodations to travelers. The focal value proposition in value creation is to provide its customers with affordable accommodations and experiences. Further, value creation consists of activities. Airbnb provides hosts a 24-hour-service which is an activity of the type service. A money flow activity, for instance, is Airbnb paying the surplus to the host after the check-in of the customer. Also, boundary resources are used by Airbnb. Boundary resources are, for example, templates they offer so hosts can post their accommodations on the platform. Activities are provided through value ports, which are themselves grouped by value interfaces. These entities cannot be seen in real life as they are used to represent the willingness to provide and to group activities. Actors depend on each other's activities as without the hosts providing their accommodations, the traveler cannot book any.

The platform is the core of the platform ecosystem as it coordinates all activities. It also enables transactions between the actors as the booking process takes place over the platform. The platform consists of a core, and periphery. The platform's core is the backend of the platform since Airbnb is a digital platform. The periphery comprises different user interfaces that travelers or hosts use to interact with the platform.

Last, the platform is influenced by network effects. The network effects arise between the hosts and the customer. The more travelers Airbnb attracts, the more hosts are tempted to post their accommodations on the platform. Thus, the network effects in the case of Airbnb are indirect.

The first real-world case shows that platform ecosystem aspects of Airbnb can be captured within the domain ontology.

5.2 Albrecht-Dürer Airport

Next, the Albrecht-Dürer airport Nürnberg – a physical platform ecosystem – is analyzed. Passengers can book tickets for flights and events at the airport. The airport offers passengers check-in, baggage drop-off, parking, and other services such as flight information or barrier-free travel [23]. Furthermore, the Albrecht-Dürer airport incorporates shopping facilities provided by shopkeepers. They can rent salesrooms for their shops on the platform [24]. The platform offers airlines various services, such as ground handling or the provision of runways, which they can use for a fee [25]. Besides, advertising space is available at the airport, which partners can rent. Travel agencies receive information about the airport and discounted parking via a website [26].

The platform ecosystem consists of a platform and an ecosystem. The platform is the Albrecht-Dürer airport and has the type transaction platform. The ecosystem consists of a platform owner who is the Flughafen Nürnberg GmbH and several actors. These actors are passengers, airlines, shopkeepers, advertisement partners, and travel agencies. They are partners of the platform owner.

A platform ecosystem operates value creation by carrying out flights. The focal value proposition of the value creation is to provide passengers with pleasant traveling experiences. To fulfill the value creation, activities are carried out by the actors. Activities of the type services are, e.g., offering check-in and baggage drop-off. The airlines must pay a fee to use services provided by the airport which is an activity of

the type money flow. Boundary resources are, for instance, salesrooms. Selling goods is an activity of the type flow of goods. The actors depend on each other's activities.

The platform is again the core of the ecosystem as it coordinates all activities and enables transactions between the actors. Further, the platform governs the actors and the structure of the platform ecosystem.

The platform consists of a core, periphery, and a platform owner. The core is the building and the central concept of the airport. The periphery are the different services that are provided to and by groups of actors.

Indirect network effects influence the airport. They arise between the airlines and the passengers and between the shopkeepers and passengers.

The Albrecht-Dürer airport is a non-digital platform that interacts with many actors, which is why many activities take place within the platform ecosystem. Nevertheless, this platform could also be represented with the ontology.

5.3 Amazon

The last platform ecosystem to be analyzed is Amazon. Amazon is a marketplace where retailers offer their products. Retailers can publish their products on the platform, and Amazon provides shipping, payment processing, marketing and advertising services [27]. For these services, retailers pay a monthly contribution to Amazon.

The platform is customer-oriented and tries to make the shopping experience as pleasant as possible. On Amazon, customers are offered many services such as Amazon Prime, Prime Now, and especially for businesses, Amazon Business. These services are subscriptions. Amazon Prime offers customers free shipping on some products and many other services, such as streaming series and movies through Prime Video. Prime Now is included in Amazon Prime and offers customers the delivery of products within one or two hours [28].

Amazon partners with logistics companies. For example, the platform provides them with training or accounting services. The logistics partners receive certain tariffs for the delivery of orders [29].

This platform ecosystem consists of an ecosystem and the platform Amazon. The platform is an integrated platform. The ecosystem consists of the platform owner Amazon and the actors. Actors of this ecosystem are customers, companies who place orders via Amazon from sellers, and logistic partners. They are partners of the platform owner.

The platform ecosystem operates value creation by selling goods and services online. The focal value proposition is to provide their customers with a pleasant shopping experience. Activities that are carried out to fulfill the value proposition include providing services like Amazon Prime or Prime Now. Also, activities of the type goods and money flows are carried out. For instance, selling goods is an activity of the type goods, and paying for the goods is of the type money flow. Amazon provides as boundary resources , e.g., trainings for logistic companies. The actors depend on each other's activities.

In this platform ecosystem, the platform is again the core. It coordinates the activities as the buying process is carried out through the platform. Also, the platform enables transactions between the actors and governs them and their structure.

The platform consists of a core, periphery, and a platform owner. The core is again the backend of the platform, and the periphery are the user interfaces the actors use to interact with the platform.

Amazon is an integrated platform that is customer-oriented. Customer orientation can be seen in the fact that many services are offered to consumers. All essential characteristics of the platform ecosystem are documented in the ontology.

6 Discussion

As the three online case studies in the evaluation show, the ontology can capture the essential concepts of those platform ecosystems. Further, the fulfillment of the requirements requires verification.

The first requirement is to represent platforms from both the market-oriented and technological perspectives. The use case of an airport shows this incidence particularly well. On the one hand, network effects from the market-oriented perspective arise between the platform owner and the other actors since the airport itself functions as a marketplace. On the other hand, the mere physical facilities of the airport, i.e., the building, runways, and airplane and car parking lots, function as the technological core of the platform. Additionally, complementors, i.e., airlines, shop owners, and tourism offices, create a pleasant stay at the airport for travelers. Thus, the ontology can express even physical platforms from both the technological and the market-oriented perspective on platforms.

The evaluation presents the integration of actors and activities in a platform ecosystem. The entities Activity and Actors relate to entities that represent characteristics of platforms and ecosystems. Therefore, they are also the entities that show the collaboration between the ecosystem and the platform. Another entity that connects the platform and the ecosystem is the Value Creation as both the ecosystem and the platform operate it.

In conclusion, the ontology met all previously defined requirements. However, since an ontology is a far abstraction of a real-world phenomenon, some information is always be obscured. For instance, when focusing on a digital platform, boundary resources like application programming interface gains importance. The present ontology tries to capture platform ecosystems at their essence, which is neither merely digital nor physical. Thus, the scope of the ontology was set up in a broader sense.

The ontology contributes a clearer understanding of platform ecosystems. According to Schreieck et al. [2] the literature provides different perspectives on platform ecosystems. Nevertheless, platform-based businesses cannot be described by only one of the perspectives. To better understand platform ecosystems, the perspectives must be integrated as they do not exclude each other.

De Reuver et al. [3] describes a conceptual ambiguity in literature as new research challenges arise. These are a result of the exponentially growing platform innovation,

the increasing difficulty of platform architectures, and the spread of digital platforms to different industries. In this paper, a domain ontology was established to counteract the conceptual ambiguity.

Despite the best efforts, the present paper underlies some limitations. The paper aims to develop a domain ontology that contains the main concepts of platform ecosystems. The ontology is not based on a structured literature review. However, since this paper relies on the structured overview in Schreieck et al. [2], the ontology should capture common knowledge about platform ecosystems.

Further, the literature about platforms and ecosystems often contains various definitions. Sometimes the definitions differ from each other, which is why those had to be bridged together. Especially, the business ecosystem literature spreads wide regarding its main subjects. The present paper focuses on the core platform ecosystems concepts instead and is thereby not intended to capture the full stream of ecosystems and platforms by themselves. Additionally, the depiction of an ontology is aggravated by the mere number of subjects. Nevertheless, the selection provides a solid foundation for platform ecosystems.

The present paper contributes a platform ecosystems ontology to theory and practice. While researchers may use the ontology to facilitate clear communication about their subject of interest, practitioners aiming to develop a platform ecosystem may find it useful to see the relations and entities in it. Hence, the paper contributes to a unified view of platform ecosystems.

7 Conclusion

This paper develops an ontology, an abstraction of real-world phenomena, to contribute to a unified understanding of platform ecosystems. An ontology serves as a common ground when communicating and analyzing a particular subject of interest. The ontology was developed using the four-step method adapted from Brusa et al. [6]. Platform-ecosystem-specific requirements were derived from the literature. The resulting entity-relation model incorporates concepts from the business ecosystems, platforms, and platform ecosystems domains. The evaluation of the ontology shows that it can map three real-world platform ecosystems from different industries to the modeled elements. Therefore, the ontology has fulfilled the requirements. To this end, the domain ontology can represent the main characteristics of platform ecosystems. It includes all the main concepts of platform ecosystems that also occur in different industries. Further, the ontology can represent non-digital platforms, i.e., an airport.

The ontology provides a high-level view of platform ecosystems, representing their characteristics in an abstract manner. Facets of platform ecosystems, such as activities, relationships, ecosystem strategies, etc., could be encoded into sub ontologies to create an expandable and exhaustive abstraction of platform ecosystems. Furthermore, an interview-based evaluation of platform-ecosystem concepts and thereby, the presented ontology might provide deeper insights into the importance of every single aspect in the literature.

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